98 Rec'd PCT/PTO 11 JAN 2002

FORM PTO-1390 (REV 5-93)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY DOCKET NO. 103120-00030
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		DATE: January 11, 2002
		U.S. APPLN. NO. (IF KNOWN, SEE 37 C.F.R. 1.5) Not Yet Assigned 10/030083
INTERNATIONAL APPLICATION NO. PCT/FR00/02018	INTERNATIONAL FILING DATE 12 July 2000	PRIORITY DATE CLAIMED 12 July 1999

TITLE OF INVENTION: RECTANGULAR RESPONSE OPTICAL FILTER FOR PARTITIONING A LIMITED SPECTRAL INTERVAL

APPLICANT(S) FOR DO/EO/US: LEFEVRE, Hervé

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371. (THE BASIC FILING FEE IS ATTACHED)
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures [35 U.S.C. 371(f)] at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper demand for International Preliminary Amendment was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed [35 U.S.C. 371(c)(2)]
   - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   - b. ☒ has been transmitted by the International Bureau.
   - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English [35 U.S.C. 371(c)(2)].
7. ☒ Amendments to the claims of the International Application under PCT Article 19 [35 U.S.C. 371(c)(3)]
   - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   - b. ☐ have been transmitted by the International Bureau.
   - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   - d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 [35 U.S.C. 371(c)(3)].
9. ☐ An oath or declaration of the inventor(s) [35 U.S.C. 371(c)(4)].
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 [35 U.S.C. 371(c)(5)].

Items 11 - 16 below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: ☐
    Drawings (8 sheets)

531 Rec'd PCT/PTO 11 JAN 2002

U.S. APPLN. NO. (IF KNOWN, SEE 37 C.F.R. 1.50) Not Yet Assigned 10/030083	INTERNATIONAL APPLICATION NO. PCT/FR00/02018	ATTORNEY DOCKET NO. 103120-00030 DATE: January 11, 2002

	CALCULATIONS	PTO USE ONLY
17. ☒ The following fees are submitted: **Basic National Fee [37 C.F.R. 1.492(a)(1)-(5)]:** Search Report has been prepared by the EPO or JPO............$890.00 International preliminary examination fee paid to USPTO (37 C.F.R. 1.482)..$710.00 No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO [37 C.F.R. 1.445(a)(2)].....................................$740.00 Neither international preliminary examination fee (37 C.F.R. 1.482) or international search fee [37 C.F.R. 1.445(a)(2)] paid to USPTO......................$1,040.00 International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)..$ 100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 1040.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date [37 C.F.R. 1.492(e)].	$ 0.00	

Claims	Number Filed	Number Extra	Rate		
Total Claims	36 - 20 =	16	X $ 18.00	$ 288.00	
Independent Claims	1 - 3 =	0	X $ 84.00	$ 0.00	
Multiple dependent claim(s) (if applicable)			+ $280.00	$ 280.00	

TOTAL OF ABOVE CALCULATIONS =	$ 1608.00	
Reduction by one-half for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 C.F.R. 1.9, 1.27, 1.28).	$ 0.00	
SUBTOTAL =	$ 1608.00	
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date [37 C.F.R. 1.492(f)]. +	$ 0.00	
TOTAL NATIONAL FEE =	$ 1608.00	
Fee for recording the enclosed assignment [37 C.F.R. 1.21(h)]. The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). $40.00 per property +	$ 0.00	
TOTAL FEES ENCLOSED =	$ 1608.00	
	Amount to be refunded	$
	Charged	$

a. ☒ A check in the amount of $1608.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. 01-2300 in the amount of $ to cover the above fee. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 01-2300.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive [37 C.F.R. 1.137(a) or (b)] must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Arent Fox Kintner Plotkin & Kahn
1050 Connecticut Avenue, N.W.
Suite 400
Washington, D.C. 20036-5339
Tel: (202) 857-6000 Fax: (202) 638-4810
GEO/aam

George E Oram Jr

George E. Oram, Jr.
Reg. No. 27,931

#3/a

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of:

Herve LEFEVRE

Group Art Unit: Unknown

Serial No.: Unknown

Examiner: Unknown

Filed: January 11, 2002

Docket No. 103120-00030

For: RECTANGULAR RESPONSE OPTICAL FILTER FOR PARTITIONING A LIMITED SPECTRAL INTERVAL

PRELIMINARY AMENDMENT UNDER 37 C.F.R. 1.121

Commissioner for Patents
Washington, D.C. 20231

January 11, 2002

Sir:

Prior to calculation of the filing fee and prior to examination of the concurrently filed above-identified application, please amend the application as follows:

IN THE CLAIMS:

Please amend the claims as follows:

6. (Amended) An optical filter according to one of the claims 1 or 2, characterized in that it comprises a folding reflector doubling the number of passages of the light beam on the grating.

7. (Amended) An optical filter according to one of the claims 1 or 2, characterized in that the reflector of Littman-Metcalf configuration is a planar mirror connected to a bi-prism.

8. (Amended) An optical filter according to one of the claims 1 or 2, characterized in that the reflector of Littman-Metcalf configuration is a truncated dihedron.

Please add the following new claims:

9. (New) An optical filter according to claim 3, characterized in that it comprises a folding reflector doubling the number of passages of the light beam on the grating.

10. (New) An optical filter according to claim 4, characterized in that it comprises a folding reflector doubling the number of passages of the light beam on the grating.

11. (New) An optical filter according to claim 5, characterized in that it comprises a folding reflector doubling the number of passages of the light beam on the grating.

12. (New) An optical filter according to claim 3, characterized in that the reflector of Littman-Metcalf configuration is a planar mirror connected to a bi-prism.

13. (New) An optical filter according to claim 4, characterized in that the reflector of Littman-Metcalf configuration is a planar mirror connected to a bi-prism.

14. (New) An optical filter according to claim 5, characterized in that the reflector of Littman-Metcalf configuration is a planar mirror connected to a bi-prism.

15. (New) An optical filter according to claim 6, characterized in that the reflector of Littman-Metcalf configuration is a planar mirror connected to a bi-prism.

16. (New) An optical filter according to claim 3, characterized in that the reflector of Littman-Metcalf configuration is a truncated dihedron.

17. (New) An optical filter according to claim 4, characterized in that the reflector of Littman-Metcalf configuration is a truncated dihedron.

18. (New) An optical filter according to claim 5, characterized in that the reflector of Littman-Metcalf configuration is a truncated dihedron.

19. (New) An optical filter according to claim 6, characterized in that the reflector of Littman-Metcalf configuration is a truncated dihedron.

REMARKS

The above amendments are being submitted to correct the multiple dependencies of the claims as filed. No new matter is being added. Clear support is found in the original specification and claims. Claims 1 - 19 are being submitted for consideration.

Accordingly, an early examination and a favorable action on the merits are respectfully requested.

Any additional fees that may be due with respect to this paper may be charged to Counsel's Deposit Account No. 01-2300.

Respectfully submitted,

ARENT FOX KINTNER PLOTKIN & KAHN, PLLC

George E. Oram, Jr.

George E. Oram, Jr.
Attorney for Applicants
Registration No. 27,931

1050 Connecticut Avenue, NW
Suite 400
Washington, DC 20036-5339
Tel: (202) 828-3455
Fax: (202) 638-4808

GEO/bgk

Attorney docket no. 103120-00030

AMENDMENTS TO THE CLAIMS:

6. (Amended) An optical filter according to one of the claims [1 to 5] 1 or 2, characterized in that it comprises a folding reflector doubling the number of passages of the light beam on the grating.

7. (Amended) An optical filter according to one of the claims [1 to 6] 1 or 2, characterized in that the reflector of Littman-Metcalf configuration is a planar mirror connected to a bi-prism.

8. (Amended) An optical filter according to one of the claims [1 to 6] 1 or 2, characterized in that the reflector of Littman-Metcalf configuration is a truncated dihedron.

PRTS
10/030083
531 Rec'd PCT/PTO 11 JAN 2002

RECTANGULAR RESPONSE OPTICAL FILTER FOR PARTITIONING A LIMITED SPECTRAL INTERVAL

This invention concerns a rectangular response optical filter for partitioning a limited spectral interval and having optical fibres, preferably single mode fibres, as input and output gates.

The evolution of wavelength multiplexed optical fibre telecommunications requires the development and the optimisation of such devices. It has been sought in particular to partition a wide spectrum into spectral domains, here called limited spectral intervals, while avoiding any superimpositions and cross-talk that might derive therefrom.

Numerous devices have already been proposed to that effect, whereas most of them consist in spreading the luminous spectrum in a plane and in placing in the said plane, a slot delineating the narrow spectral band that one wishes to select, but then the light cannot be recoupled efficiently in a monomode optical fibre.

Other devices implement sets of optically guided components: couplers, multiplexers-demultiplexers,...

The optimisation of such devices implies the provision of rectangular transmission functions and without loss in the limited spectral interval light flux selected, i.e. in a representation of the intensity of the light flux transmitted as a function of the wavelength as that on Figure 1, the edges of the partitioned band should be as vertical as possible, the apex should be as flat as possible and the losses as little as possible. The apex can be flattened according to the state-of-the-art by generating losses.

We also know a document (I. Nishi and al., December 1987) that divulges a wide-band multiplexer-demultiplexer for multimode filter. It suggests the implementation of a retrodispersing system in Littrow configuration with respect to an input fibre and to output fibres. This document specifies that the width of the pass-band of such a device is determined by the length of the retroreflector.

Besides, in a published article (Chi-Luen Wang and al., 1994), is described an external cavity laser wherein the external cavity is set up so that it enables filtering of two wavelengths. Filtering is performed by reflecting bands forming reflecting mirrors co-operating with a grating.

The implementation of the teachings of these documents does not enable to realise a transmission-stable device and ensuring good accuracy.

The inventors have set themselves the target of providing such a device implementing a grating-reflector assembly in Littman-Metcalf configuration in order to take advantage of the high performances offered by such a type of configuration and that such a device does not generate any losses and possesses optical fibres, preferably monomode, as input and output gates, ensuring optimized stability and accuracy.

Thus, the invention concerns a rectangular response optical filter for partitioning a limited spectral interval in a wide spectrum light flux comprising :

- an input optical fibre having one end,
- a grating-reflector assembly in Littman-Metcalf configuration,
- a converging collimation optical system at whose focal point is located the end of the input fibre,
- a converging focusing optical system placed between the grating and the reflector,
- at least one reflector placed in the focal plane of the focusing optical system whose dimension is limited in the dispersion plane, whereas the position and limited dimension of the reflector in the dispersion plane determine the partitioned spectral interval.

According to the invention, the optical filter comprises a polarisation separator placed between the input fibre and the grating and generating two elementary light beams parallel and polarised orthogonally with respect to one another, whereas a plate $\lambda/2$ is placed on one of the elementary beams in order to generate two elementary parallel beams polarised in a direction perpendicular to the lines of the grating, whereas the reflector of Littman-Metcalf configuration is sending each elementary beam back to path and in opposite direction in relation to one another.

In different embodiments each exhibiting its own specific advantages and liable to be used in the compatible technically combinations:

- the input optical fibre is a monomode fibre,
- the light flux generated with limited spectrum is collected in an output optical fibre distinct from the input fibre and of the same type as the latter,
- the optical filter comprises several optical output fibres, each connected to a reflector, whereas these reflectors are positioned in the focal plane of the

focusing optical system and have a small dimension in the dispersion plane while determining a particular spectral interval,

- the light flux generated with limited spectrum is collected by the input fibre and the latter carries an optical circulator enabling to separate the output flux from the incoming flux without any energy loss,

- the optical filter comprises a folding reflector doubling the number of passages of the light beam on the grating,

- the reflector of Littman-Metcalf configuration is a planar mirror connected to a bi-prism,

- the reflector of Littman-Metcalf configuration is a truncated dihedron.

The invention will be described in more detail with reference to the appended drawings wherein:

- Figure 1 represents a spectrum partitioned by the device of the invention;

- Figure 2 represents a device of the invention implemented with a circulator;

- Figures 3A and 3B represent a Littman-Metcalf configuration used conventionally;

- Figures 4A and 4B represent a first embodiment of the invention;

- Figures 5A and 5B represent a first embodiment of the invention, with compensation of the polarisation effects due to the grating ;

- Figures 6A and 6B represent a second embodiment of the invention implementing an output fibre distinct from the input fibre;

- Figure 7 is a detailed view of a reflector implemented in the second embodiment ;

- Figure 8 is a detailed view of an alternative reflector type that can be implemented in the second embodiment ;

- Figures 9A, 9B and 9C represent a fourth embodiment of the invention ;

- Figure 10 is an embodiment of the invention implementing an alternative reflector in the first embodiment of the invention.

Figure 1 is therefore a diagram representing the energy of the light flux coming from the partitioning device of the invention, as a function of wavelength λ. The incoming spectrum extends supposedly over a long range, in wavelength, on the basis of the scale of this extended diagram and the device of the invention enables to partition a narrow band represented by a function as

close as possible to a rectangular function, with width $\Delta\lambda$ centred on a wavelength λ_i.

The device of the invention comprises therefore an input fibre 1 having one end 2. The partitioning device of the invention as a whole is designated by the reference 3. This device comprises a grating 4-reflector 5 assembly in Littman-Metcalf configuration.

We know that in the conventional Littman-Metcalf configuration, represented on Figures 3A and 3B, the incident collimated beam describes an angle θ_1 with respect to the normal to the grating. A reflector R is placed with its normal having an angle θ_2 to the grating. The wavelength λ that complies with the condition $\lambda = p\,(\sin\theta_1 + \sin\theta_2)$ where p is the pitch of the grating, is dispersed by the grating at an angle θ_2 then retroreflected by the reflector that is then perpendicular to the latter. Finally, it is dispersed again in the grating on the way back and comes out under the input angle θ_1. The wavelength λ is therefore selected by the cavity. That wavelength λ can be varied while changing the orientation of the grating-reflector assembly, i.e. while changing θ_1 or while changing solely the orientation of the reflector, i.e. while changing θ_2 or finally while changing solely the orientation of the grating, i.e. while changing θ_1 and θ_2 while keeping $\theta_1 - \theta_2$ constant.

In the description of such devices, it is customary to call dispersion plane the plane perpendicular to the lines of the grating containing the central ray of the incident beam and the central rays of the beams dispersed by the grating, it is shown on Figure 3B.

For each beam, transversal plane shall designate the plane perpendicular to the central ray and longitudinal plane shall designate the plane perpendicular to the dispersion plane containing the central ray. The longitudinal plane is therefore that on Figure 3A.

On the various appended figures, view A is an unfolded view, i.e. wherein the beam dispersed 7 by the grating 4 has been represented in the direct extension of the incident beam 6 for better readability. View B is a representation from beneath, i.e. in a plane parallel to the dispersion plane.

Figure 4 with its views A and B shows a system wherein the selection in wavelength is conducted by the geometrical dimensions of a mirror connected to a grating in Littman-Metcalf configuration. A converging optical system 8 at whose focal point is placed the end 2 of the input fibre 1, collimates the beam 9 emitted from the end of the fibre, so that the incident beam 6 on the grating is a

collimated beam. Thus, the dispersed beam(s) 7 are also collimated beams and a converging optical system 10 focuses these beams in its focal plane 4' wherein is placed a mirror 5 which has a limited dimension d in the dispersion plane as shown on Figure 4B. For the wavelengths corresponding to the beams 7' reflected on the mirror, the system behaves like a cat's eye, and hence these wavelengths are re-coupled on the way back in the input fibre, regardless whether it is monomode or multimode.

Thus, this mirror only reflects towards the optical system 10 and hence towards the grating 4, a limited portion of the spectrum, whereas the wavelengths corresponding to the external beams 7" are not reflected.

This flux is partitioned and coupled on the way back by the optical system 8 then by the optical fibre 1 which therefore in that embodiment, acts as an input and output optical fibre.

Different devices can be considered to separate the input fluxes and the output fluxes so that, in particular, preferably, Figure 2 shows a circulator that enables to realise such separation with minimal energy losses.

The input-output fibre 1 connected to the partitioning device 3 is therefore connected to its other end to the circulator 11 which possesses an input 12 and an output 13.

This wavelength selection device operates correctly, but is still proving unstable and is providing inaccurate light fluxes or signals.

To remedy these shortcomings, we have endeavoured, according to the invention, to break free from the polarisation defects.

Thus, as represented on Figures 5A and 5B, we have implemented a device compensating for the known polarisation effects liable to be induced by the grating 4 and to generate spurious effects.

To that effect, the collimated beam 6 emerging from the optical system 8 is divided by the polarisation separator 14 into two parallel beams, respectively 15 and 16, with cross polarisation. A plate $\lambda/2$ 17 modifies the flux polarisation 16, so that the flux 15 and the modified flux 18 are polarised in a similar fashion and undergo therefore exactly the same effects from the grating 4. The lens 10 causes each of these beams to converge onto the mirror 5 which exchanges their paths, which means that the return paths of the beams 18 and 15 are exchanged after reflection onto the mirror 5, whereas the beam 18 follows the optical path of the beam 15 on its way out and vice-versa.

Thus, the beams 18 and 15 are recombined on the way back and have undergone exactly the same effects of the grating 4.

Thus, any spurious effect liable to be generated by the grating in relation to the polarisation and the shape of the spectral distribution of the partitioned light flux is therefore improved

Different preferred embodiments enable the implementation of the device described above and each of them enhances the thinness of the partitioned spectral band and possibly, in order to partition a greater number of elementary bands in the incident wide spectrum.

Figures 6A and 6B represent an embodiment wherein the output fibre 20 is distinct from the input fibre 1.

To that effect, the mirror 5 is replaced with a reflector 21 which, seen in the longitudinal plane, has the shape of a dihedron whereas it keeps a small dimension d in the dispersion plane.

As represented in the longitudinal plane, this dihedron 21 is positioned with respect to the converging optical system 10 so that after reflection onto each of the faces of the dihedron 21, the parallel incoming beams in the optical system 10 converge into a beam 41 in the middle plane 22 of the dihedron 21 and emerge in the shape of a symmetrical beam 42, enabling as well as the beam 23 transmitted by the fibre 1, forming a beam 24 which is symmetrical to the beam 23 with respect to the optical axis 25 of the system and is received by the fibre 20 set symmetrically with respect to that axis of the input fibre 1.

Such a dihedron is represented more in detail on Figure 7 and this component can be replaced in a similar fashion by the assembly represented on Figure 8 consisting of a biprism 30 and a mirror 31. As the mirror 31 is perpendicular to the axis of symmetry of the biprism 30, an incoming beam 41 generating the beam 33 by the deviation of the biprism 30 is converging in the plane of the mirror 31 and reflected symmetrically. The mirror 31 generating a beam 32 which, after deviation by the biprism 30, produces a beam 42. The beam 42 is symmetrical to the beam 41. This component 30, 31 therefore enables, as the reflector 21, the realisation of a beam 35 to be received by the fibre 20 from the beam 23 transmitted by the fibre 1.

Figures 9 (9A, 9B, 9C) represent an embodiment of the invention enabling simultaneously to compensate for the biasing effects as stated above, to linearise the distribution of the spectrum, in frequency, in the partitioning zone and to compensate for the anamorphosis normally induced by the grating.

To that effect, a polarisation separator is placed after the converging optical system 8 and breaks down the incident light beam 9 generated by the input optical fibre 1 into two beams 15 and 18. A prism 27 is then placed on the beams and realises a first dispersion before that produced by the grating 4.

We know that it is thus possible to generate, thanks to the association of the prism 27 and of the grating 4, a frequency-linear dispersion.

The light beams are then folded back onto themselves by a reflector 26 which therefore sends them back, in reverse direction, onto the dispersing assembly formed by the grating 4 and the prism 27.

For better readability, Figures 9 shows independently, on view A, a transversal representation of the device as the views A of Figures 3, 4, 5, 6, on view B, a view in the dispersion plane corresponding to the upper stage of view A and, on view C, a view of this same dispersion plane of the lower stage of view A.

At the upper stage, after new dispersion by the grating 4-prism 27 assembly, the optical collimating system 10 focuses these beams onto the mirror 5 which proceeds to the requested spectral selection.

The beams selected are then reflected and follow a path reverse from that described until now to converge on the way back onto the end 2 of the fibre 1.

Thus, the polarisation separation enables symmetrical action of the grating during each of these passages and avoids therefore any spurious effect, the association of a prism and of a grating enables frequency linearization in the spreading plane of the spectrum, i.e. in the plane of the mirror 5, the double passage of each of the beams through the dispersing assembly (grating-prism) ensures compensation for the anamorphosis and hence efficient coupling of the beam outgoing in the fibre 1. This fourth embodiment can be used in combination with the third embodiment while replacing the single fibre by an input fibre and one or several output fibres and while replacing the mirror by one or several reflecting dihedral or mirror-biprism assemblies.

It may also be useful to associate each fibre with a microlens in order to reduce the divergence of the beam 9.

Finally, this filter may be tuneable while modifying the position or the width d of the reflector, or while placing in rotation the grating or the collimation optical system – reflector assembly – or finally the folding reflector 26.

Connected to a detector, this filter enables to realise an analyser for rectangular spectral response optical spectrum.

Figure 10 represents an embodiment of the invention wherein the output fibre is distinct from the input fibre and wherein a reflector as that represented and described by reference to Figure 8, is used.

The elements represented on the previous Figures have been designated by the same numerical references, as on Figures 6A and 6B, the beam 23 transmitted by the fibre 1 forms a beam 24 symmetrical to the beam 23 with respect to the optical axis 25 of the system.

The polarisation separator 14 splits the incoming beam 23 into two parallel beams, respectively 15 and 16. After reflection onto the mirror 31 and having been deviated by the biprism 30 before reflection as well as after reflection, both these beams pass again through the assembly formed by the plate λ/2 17 and the polarisation separator 14 in order to form the return beam 24 that is coupled to the optical fibre 20. Solely the reflected beam 15' from the beam 15 is subject to the plate λ/2 17. Conversely, the reflected beam 18' from the incident beam 18 is sent to the polarisation separator 14 without being subject to the effect of that plate λ/2. The beams 18' and 16' (generated from the beam 15' by the effect of the plate λ/2 17) are combined by the bias separator 14 to form the beam 24.

This device has been described with a mirror whose sizes and position are fixed.

In certain applications, it may be useful to vary the spectral width of the selected flux and/or its central wavelength. In order to control the spectral width, a slit with variable width is placed before a large mirror. The position of the slit in its plane determines the central wavelength.

CLAIMS

1. A rectangular response optical filter for partitioning a limited spectral interval in a light flux with wide spectrum comprising:

- an input optical fibre having one end,
- a grating-reflector assembly in Littman-Metcalf configuration,
- a converging collimation optical system at whose focal point is located the end of the input fibre,
- a converging focusing optical system placed between the grating and the reflector,
- at least one reflector placed in the focal plane of the focusing optical system which has a dimension limited in the dispersion plane, whereas the position and the limited dimension of the reflector in the dispersion plane determine the partitioned spectral interval,

characterised in that it comprises a polarisation separator placed between the input fibre and the grating and generating two elementary light beams parallel and polarised orthogonally with respect to one another, whereas a plate $\lambda/2$ is placed on one of the elementary beams in order to generate two elementary parallel beams polarised in a direction perpendicular to the lines of the grating, whereas the reflector of Littman-Metcalf configuration sends back each elementary beam onto the path and in opposite direction in relation to one another.

2. An optical filter according to claim 1, characterised in that the input optical fibre is a monomode fibre.

3. An optical filter according to one of the claims 1 and 2, characterised in that the light flux generated with limited spectrum is collected in an output optical fibre distinct from the input fibre and of the same type as the latter.

4. An optical filter according to claim 3, characterised in that it comprises several optical output fibres, each of them being connected to a reflector, these reflectors being positioned in the focal plane of the focusing optical system and having a small dimension in the dispersion plane and determining a particular spectral interval.

5. An optical filter according to one of the claims 1 and 2, characterised in that the light flux generated with limited spectrum is collected by the input fibre and in that said fibre carries an optical circulator enabling to separate the output flux from the incoming flux without any energy loss.

6. An optical filter according to one of the claims 1 to 5, characterised in that it comprises a folding reflector doubling the number of passages of the light beam on the grating.

7. An optical filter according to one of the claims 1 to 6, characterised in that the reflector of Littman-Metcalf configuration is a planar mirror connected to a bi-prism.

8. An optical filter according to one of the claims 1 to 6, characterised in that the reflector of Littman-Metcalf configuration is a truncated dihedron.

(12) DEMANDE INTERNATIONALE PUBLIÉE EN VERTU DU TRAITÉ DE COOPÉRATION EN MATIÈRE DE BREVETS (PCT)

(19) Organisation Mondiale de la Propriété Intellectuelle
Bureau international

(43) Date de la publication internationale
18 janvier 2001 (18.01.2001)

PCT

(10) Numéro de publication internationale
WO 01/05006 A1

(51) Classification internationale des brevets[7]: H01S 5/10, 3/083, G02B 6/34

(21) Numéro de la demande internationale: PCT/FR00/02018

(22) Date de dépôt international: 12 juillet 2000 (12.07.2000)

(25) Langue de dépôt: français

(26) Langue de publication: français

(30) Données relatives à la priorité:
99/09024 12 juillet 1999 (12.07.1999) FR

(71) Déposant *(pour tous les États désignés sauf US)*: PHOTONETICS [FR/FR]; 52 Avenue de l'Europe, F-78160 Marly le Roi (FR).

(72) Inventeur; et
(75) Inventeur/Déposant *(pour US seulement)*: LEFEVRE, Hervé [FR/FR]; 5-15 Rue Olivier Noyer, F-75014 Paris (FR).

(74) Mandataires: MICHELET, Alain etc.; Cabinet Harle & Phelip, 7 Rue de Madrid, F-75008 Paris (FR).

(81) États désignés *(national)*: CA, JP, US.

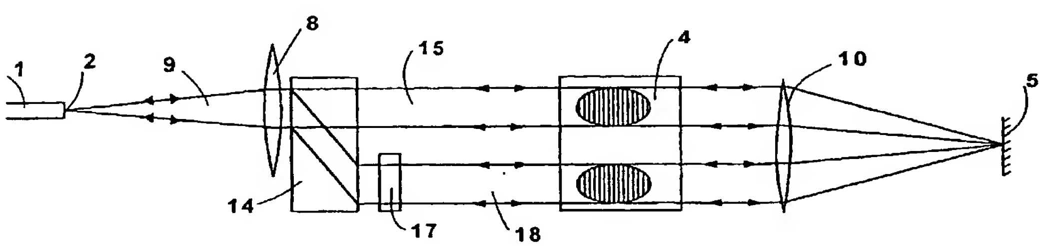
(84) États désignés *(régional)*: brevet européen (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Publiée:
— *Avec rapport de recherche internationale*
— *Avant l'expiration du délai prévu pour la modification des revendications, sera republiée si des modifications sont reçues*

En ce qui concerne les codes à deux lettres et autres abréviations, se référer aux "Notes explicatives relatives aux codes et abréviations" figurant au début de chaque numéro ordinaire de la Gazette du PCT.

(54) **Title:** RECTANGULAR RESPONSE OPTICAL FILTER FOR PARTITIONING A LIMITED SPECTRAL INTERVAL

(54) **Titre:** FILTRE OPTIQUE A REPONSE RECTANGULAIRE PERMETTANT LE DECOUPAGE D'UN INTERVALLE SPECTRAL LIMITE



(57) **Abstract:** The invention concerns a rectangular response optical filter for partitioning a limited spectral interval in a light flux with large spectrum comprising: a preferably monomode input optical fibre having one end; an array-reflector assembly in Litmann-Metcalf configuration; a converging optical system collimating at whose focus is set the input fibre end; a converging focusing optical system set between the array and the reflector; one or several output fibres of the same type as the input fibre. At least one reflector is placed in the focal plane of the focusing optical system and has a limited dimension in the dispersion plane, the position and the limited dimension of the dispersion plane determining the partitioned spectral interval.

(57) **Abrégé:** L'invention concerne un filtre optique à réponse rectangulaire permettant le découpage d'un intervalle spectral limité dans un flux lumineux de spectre large comprenant: une fibre optique d'entrée de préférence monomode ayant une extrémité, un ensemble réseau-réflecteur dans la configuration de Littman-Metcalf, un système optique convergent de collimation au foyer duquel est placée l'extrémité de la fibre d'entrée, un système optique convergent de focalisation placé entre le réseau et le réflecteur, une ou plusieurs fibres de sortie de même type que la fibre d'entrée. Au moins un réflecteur est placé dans le plan focal du système optique de focalisation et a une dimension limitée dans le plan de dispersion, la position et la dimension limitée du réflecteur dans le plan de dispersion déterminant l'intervalle spectral découpé.

WO 01/05006 A1

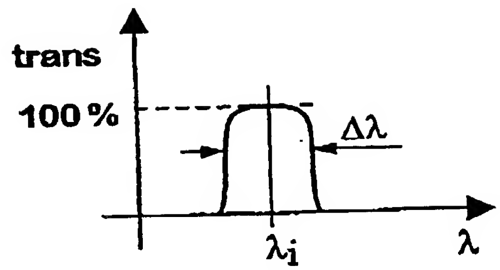


FIGURE 1

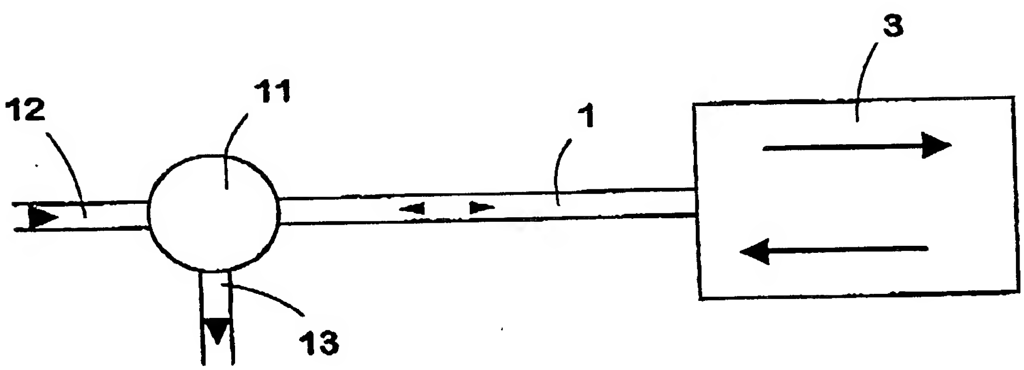


FIGURE 2

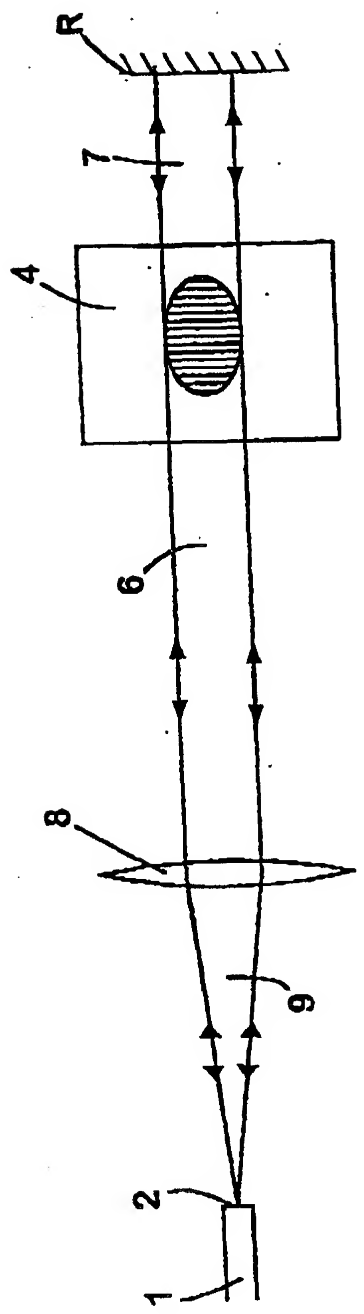


FIGURE 3A

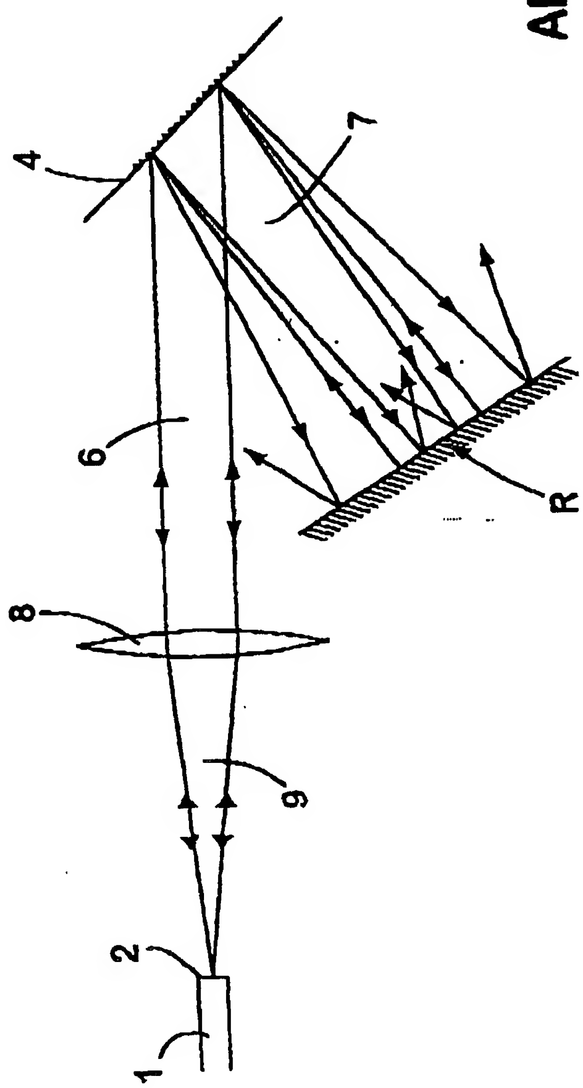


FIGURE 3B

ART ANTERIEUR

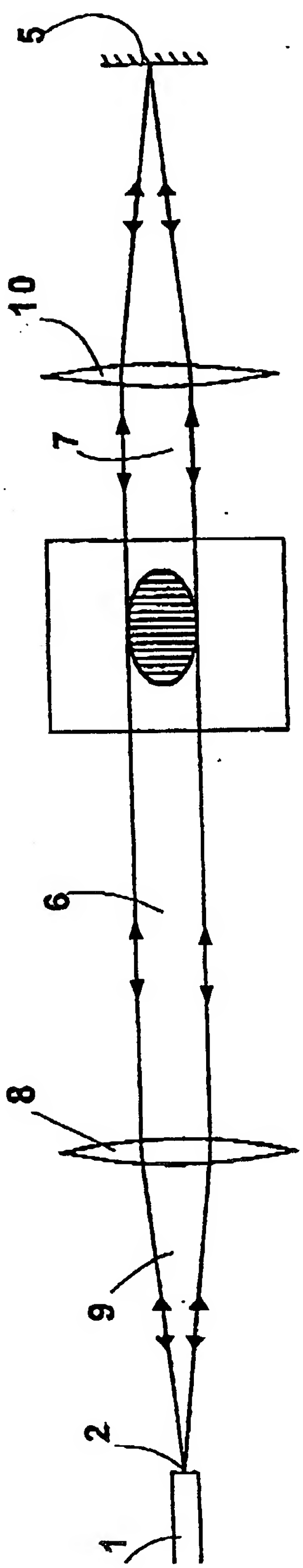


FIGURE 4A

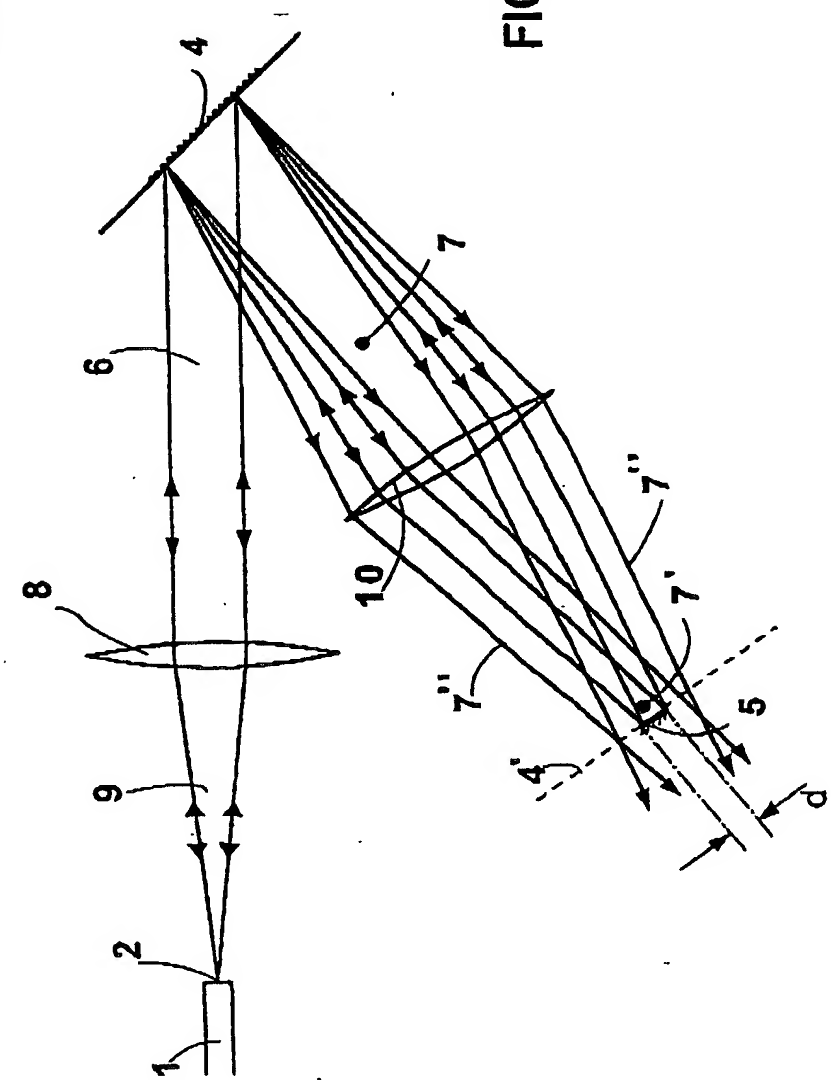


FIGURE 4B

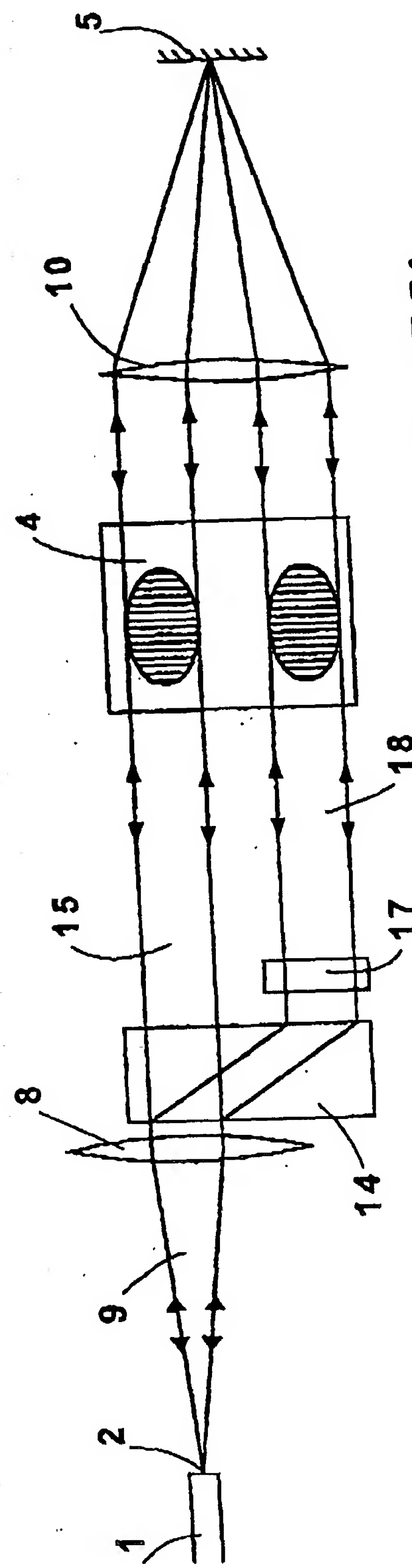


FIGURE 5A

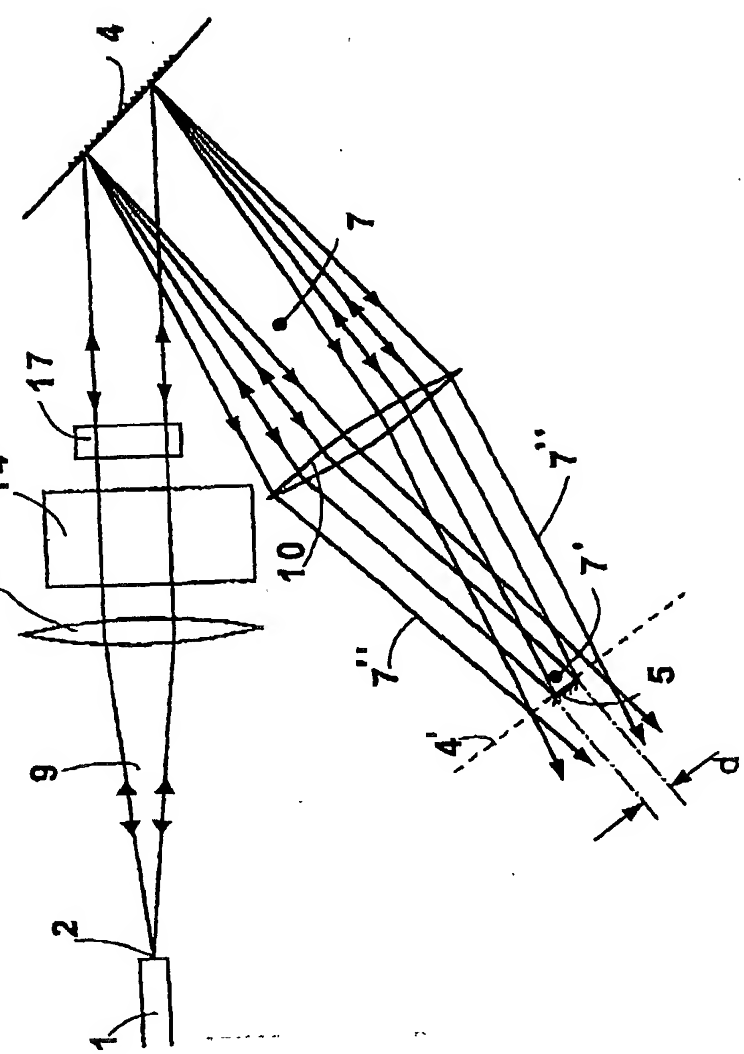


FIGURE 5B

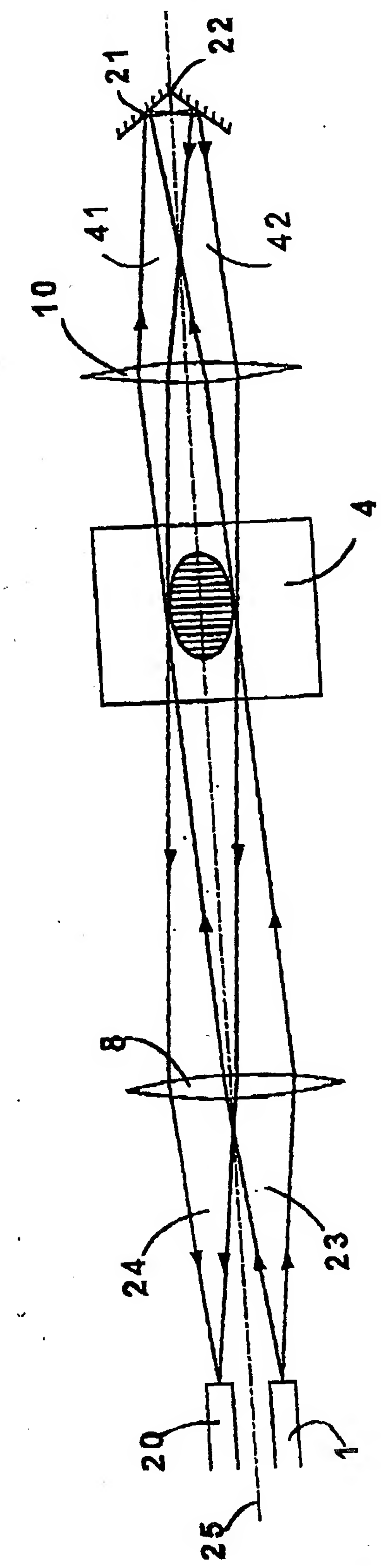


FIGURE 6A

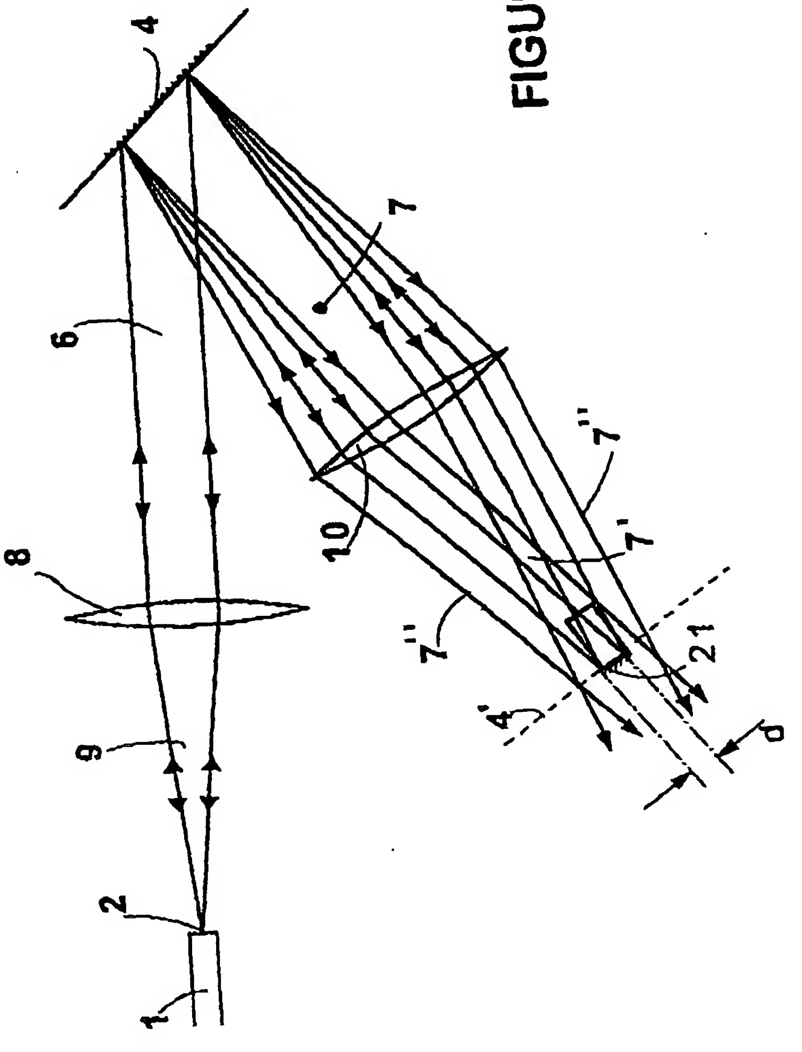


FIGURE 6B

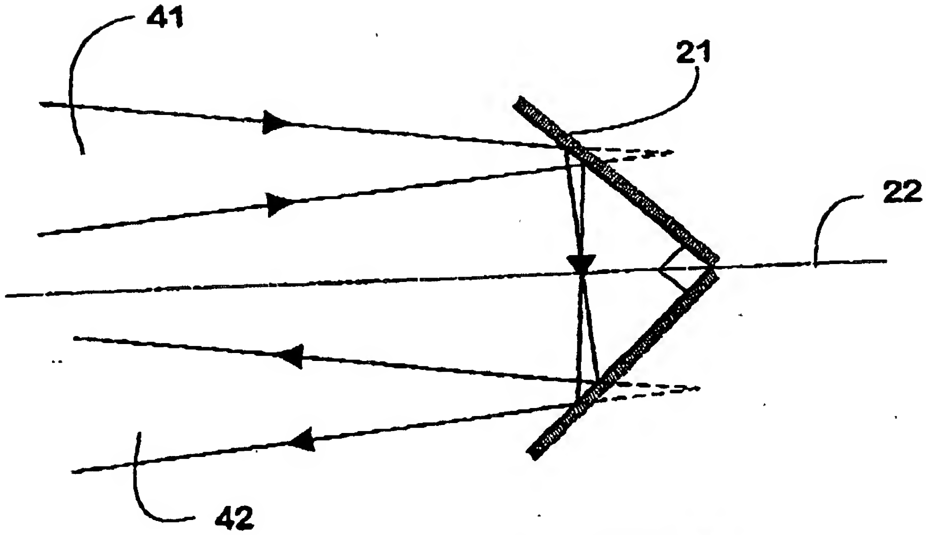


FIGURE 7

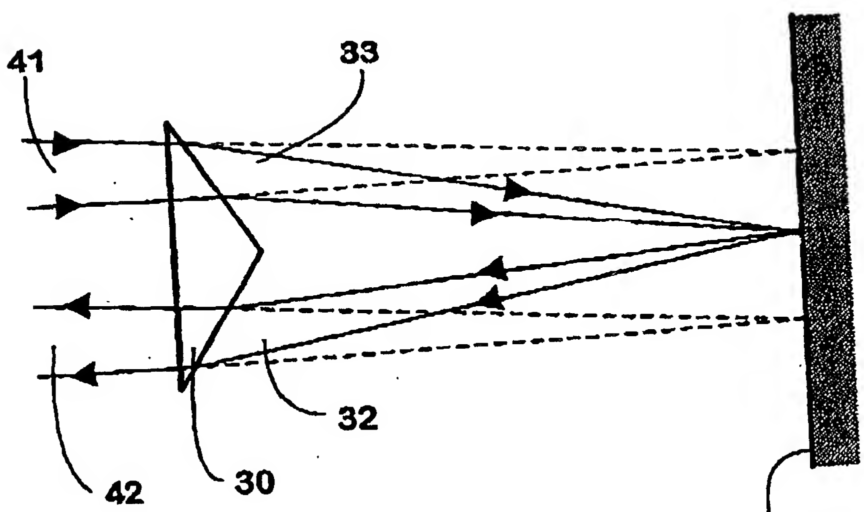


FIGURE 8

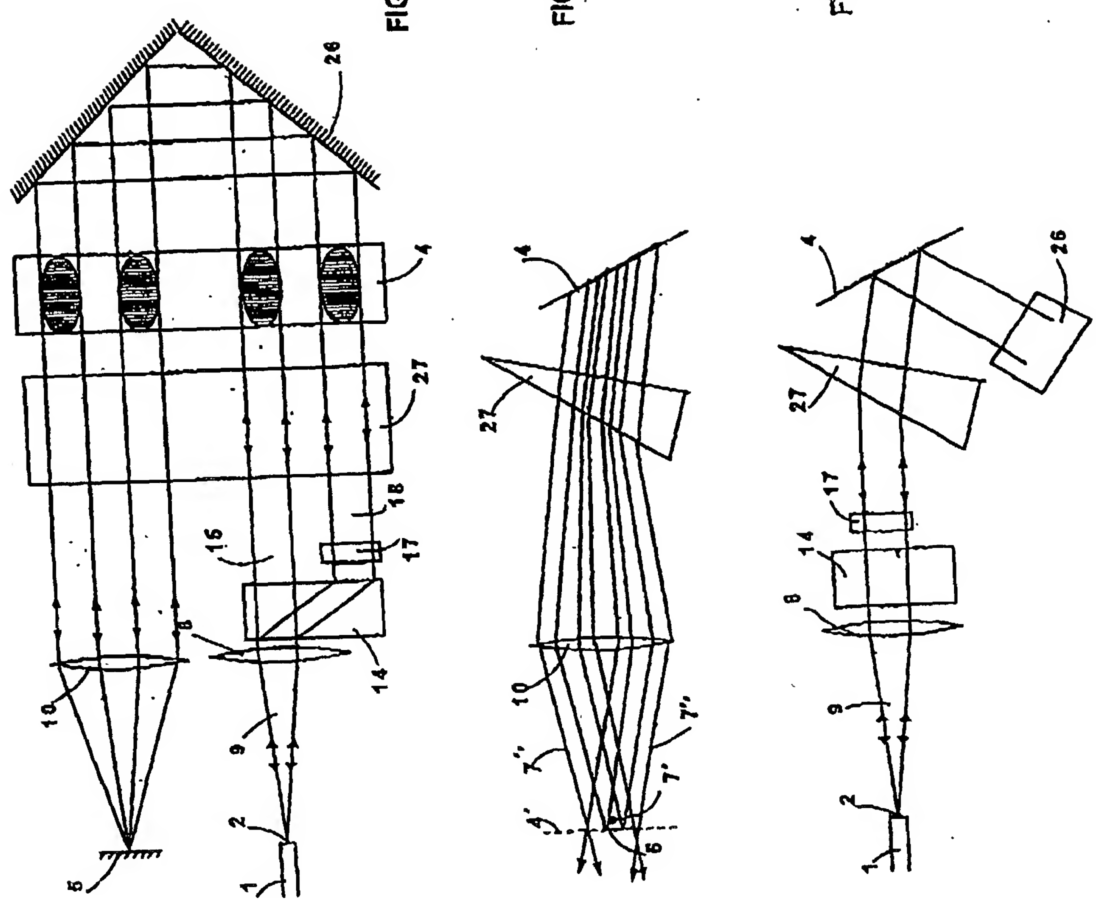


FIGURE 9A

FIGURE 9B

FIGURE 9C

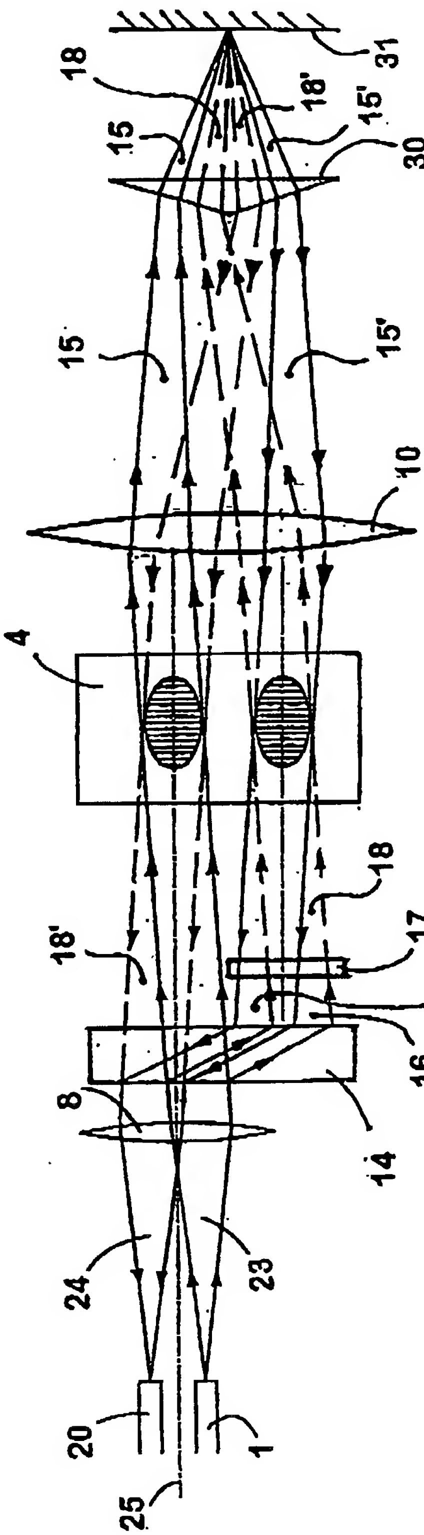


FIGURE 10

664 K PCT/US

#5

Docket No. 103120-00030 ARENT FOX KINTNER PLOTKIN & KAHN, PLLC

Declaration For U.S. Patent Application

As a below named inventor, I hereby declare that:
My residence, post office address and citizenship are as stated below my name.
I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention **entitled**
(Insert Title) RECTANGULAR RESPONSE OPTICAL FILTER FOR PARTITIONING A LIMITED SPECTRAL INTERVAL

the specification of which is attached hereto unless the following box is checked:

☒ was filed on July 12, 2000 As PCT International Application
Number ____ and was amended on ____
and/or was filed on January 11, 2002 As U.S. Patent Application
Number 10/030083 and was amended on ____.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above.
I acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. §1.56.
I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate or PCT International Application having a filing date before that of the application(s) for which priority is claimed:

(List prior foreign applications)	(Number)	(Country)	(Day/Month/Year Filed)	Priority Claimed
	99 09024	France	12 July 1999	☒ Yes ☐ No
				☐ Yes ☐ No
				☐ Yes ☐ No

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below.

(Application Number)	(Filing Date)

☐ See attached list for additional prior foreign or provisional applications.

I hereby claim the benefit under 35 U.S.C. §120 of any United States application(s) or §365(c) of any PCT International application(s) designating the United States of America listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior application(s) (U.S. or PCT) in the manner provided by the first paragraph of 35, U.S.C. §112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. §1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(List prior U.S. Applications or PCT International applications designating the U.S.)	(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

And I hereby appoint the firm of Arent Fox, Customer Number 004372 including as principal attorneys: Robert B. Murray, Reg. No. 22,980; Charles M. Marmelstein, Reg. No. 25,895; George E. Oram, Jr., Reg. No. 27,931; Douglas H. Goldhush, Reg. No. 33,125; Richard J. Berman, Reg. No. 39,107; Murat Ozgu, Reg. No. 44,275; Robert K. Carpenter, Reg. No. 34,794; Rustan Hill, Reg. No. 37,351; Kevin Turner, Reg. No. 43,437; Rhonda L. Barton, Reg. No. 47,271; Hans J. Crosby, Reg. No. 44,634, Brian A. Tollefson, Reg. No. 46,338; David D. Dzara, Reg. No. 47,543, Lynne D. Anderson, Reg. No. 46,412; Dinnatia J. Doster, Reg. No. 45,268, Michael A. Steinberg, Reg. No. 43,160 and Lynn A. Bristol, Reg. No. 48,898.

Please direct all communications to the following address:

Customer No. 004372
ARENT FOX KINTNER PLOTKIN & KAHN, PLLC
1050 Connecticut Avenue, N.W., Suite 400
Washington, D.C. 20036-5339
Telephone No. (202) 857-6000; Facsimile No. (202) 638-4810

GC(K PC)

The undersigned hereby authorizes the U.S. attorneys named herein to accept and follow instructions from the undersigned's assignee, if any, and/or, if the undersigned is not a resident of the United States, the undersigned's domestic attorney, patent attorney or patent agent, as to any action to be take in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and the undersigned. In the event of a change in the person(s) from whom instructions may be taken, the U.S. attorneys named herein will be so notified by the undersigned

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-00 Full name of sole or first inventor Hervé LEFEVRE

Inventor's signature X H Lefevre — X 02 July 2002 Date

Residence Paris, France FRX

Citizenship French

Post Office Address ~~5-15 rue Olivier Noyer, 75014 Paris, France~~ 86 Rue de Grenelle 75007 Paris France H.L.

Full name of second inventor

Inventor's signature — Date

Residence

Citizenship

Post Office Address

Full name of third inventor

Inventor's signature — Date

Residence

Citizenship

Post Office Address

Full name of forth inventor

Inventor's signature — Date

Residence

Citizenship

Post Office Address

Full name of fifth inventor

Inventor's signature — Date

Residence

Citizenship

Post Office Address

Full name of sixth inventor

Inventor's signature — Date

Residence

Citizenship

Post Office Address